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Occurrence of *Cranocrinus* Wanner in North America

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The cladid inadunate genus *Cranocrinus* Wanner is typically from Upper Permian rocks of the Island of Timor, Indonesia, and has been reported from Lower Permian rocks of the Ural Mountains of Russia. Arendt (1970) has demonstrated that juvenile *C. praestans* lacks radials (is pseudomonocyclic) while adult specimens have radials (are dicyclic). Both conditions are noted for *C. eximius* n. sp. from Morrowan (Lower Pennsylvanian) rocks of Oklahoma and are described herein. Possible methods of feeding and respiration are considered in the discussion of *Cranocrinus*.
INDEX DESCRIPTORS: Crinoidea, *Cranocrinus*, feeding, respiration; Greenleaf Lake, Muskogee County, Oklahoma; Island of Timor, Indonesia; Ural Mountains, U.S.S.R.; Brentwood Limestone Member = Braggs Member (part), Sausbee Formation, Morrowan, Lower Pennsylvanian; Lower Permian; Upper Permian.

There appears to be an influx of crinoid genera (e.g., *Cibolocrinus, Lecythiocrinus, Strongylocrinus, Calycocrinus, Cranocrinus, Lampadosocrinus*) into the Morrowan of the Oklahoma-Arkansas region which have no known ancestors in the preceding Chesterian rocks of North America. It is assumed the lineages developed in some other geographic area or areas and migrated into the region in early Morrowan time.

Two of the above genera (*Cibolocrinus* and *Lecythiocrinus*) were highly successful in Middle and Upper Pennsylvanian time in the mid-continental United States. However, three of the genera (*Strongylocrinus, Calycocrinus* and *Cranocrinus*) did not persist and did not appear again until Permian time in another geographic area. They have been reported from the Permian of southeast Asia and/or Russia. Of course they must have existed somewhere in the interim period but exhaustive collecting in North America has failed to unearth any record of them. The existence of *Cranocrinus* in North America is reported here for the first time.

Cranocrinus changes during ontogeny from a pseudomonocyclic cup (lacking a radial circlet) to a dicyclic cup (with radial plates) by intercalation of radials. Arendt (1970, fig. 34) illustrated a complete series of growth and change for *C. praestans* Arendt. Both extremes are found in *C. eximus* n. sp.; however, all stages of growth have not been recovered. Without knowledge of their ontogeny Morrowan specimens would be placed in two orders, the younger in the Disparida and the mature ones in the Cladida.

The dorsal cup of an inadunate crinoid is normally composed of either two primary alternating circlets of plates (radials and basals), and is called monocyclic, or is composed of three alternating circlets of primary plates (radials, basals, and infrabasals), and is called dicyclic. Monocyclic inadunates are classified in the order Disparida and the dicyclic ones in the order Cladida. Radial plates are considered to be the lowest elements of the rays or arms. Each circlet is composed of five plates the lowermost of which, however, may be partially or entirely fused. There are commonly "extra" plates (termed anal plates) in the CD interray or in some specimens an anal aperture or periproct is in the CD position. Oral plates, when present, commonly alternate with radials. Unfortunately, there are exceptions to all of these generalities, particularly among larviform crinoids.

The Pennsylvanian-Permian genus *Cranocrinus* Wanner, as demonstrated by *C. praestans* Arendt (1970), does not follow the commonly accepted patterns of ontogeny (Figure 1, a-c). In the juvenile stage there are three circlets of plates in alternating position but they are orals, basals and infrabasals. At this stage the crinoid appears to be monocyclic. The anal aperture is just to the left of CD oral position notching the right shoulder of CD basal. As the radials appear in ontogeny the basal bearing the aperture grows more rapidly on the right side so that the vent is in a central position in maturity. As the radials grow the orals "rotate" so the CD oral is in proper (interray) position when C and D radials are mature.

In the ontogeny of the modern crinoid *Antedon* (after Hyman, 1955) the early cystidean stage has orals, basals and infrabasals, but the orals are in series with the basals which is the proper position (interradial) in a dicyclic crinoid. An anal plate (radianal?) appears followed by the five radials. Eventually the anal plate migrates out of the cup and is apparently resorbed; the orals separate from the cup and become part of a tegmen, infrabasals fuse with the basals or proximal columnal, and eventually the cup comprises nothing more than radials and a rosette. The rosette is a fused (with some resorption) combination of proximal columnals, infrabasals and basals. Readily apparent differences between the cystidean stages of *Antedon* and juvenile stages of *Cranocrinus* are the rotation of orals in the latter as well as the development of a pronounced lateral aperture.

MATERIAL AND OCCURRENCE

Some specimens used in the present study were picked from washed residues of a soft shale exposed low on the spillway of Greenleaf Lake, Muskogee County, Oklahoma, more than 25 years ago. The exposure is located near the center of Section 10, T13N, R20E and is now covered by water backed up from the lock system on the Arkansas River. Specimens were collected by R. C. Moore and by the author from the Brentwood interval. More recently acquired specimens were recovered by my wife, Christina Strimple, from washed residues of a marl exposed in the inactive Chisholm Quarry west of Gore, Muskogee County, Oklahoma, located in SW1/4 NW1/4 section 35, T13N, R20E and from soft shales in an abandoned quarry on the east shore of Grand Lake (Lake of the Cherokees) east of Wagoner, Wagoner County, Oklahoma, in the SE1/4 section 22, T17N, R19E in the "Brentwood interval." In northwestern Arkansas the Brentwood Limestone is a Member of the Bloyd Formation, Bloydian Stage, Lower Pennsylvanian. The Bloydian is correlated with the Yeadonian Stage (Namurian C) of England (Furnish & Saunders, 1971). In current usage (Sutherland & Henry, 1977a, 1977b) the Brentwood Limestone interval is apparently in the upper portion of the Braggs Member and the Brewer Bend Limestone Member, Sausbee Formation, Morrowan Series.

REPOSITORY

All specimens are deposited in the Geology Department Repository, The University of Iowa, Iowa City, Iowa. Catalogue prefix is SUI.

SYSTEMATIC PALEONTOLOGY

Class CRINOIDEA Miller, 1821
Subclass INADUNATA Wachsmuth and Springer, 1885
Order CLADIDA Moore and Laudon, 1943

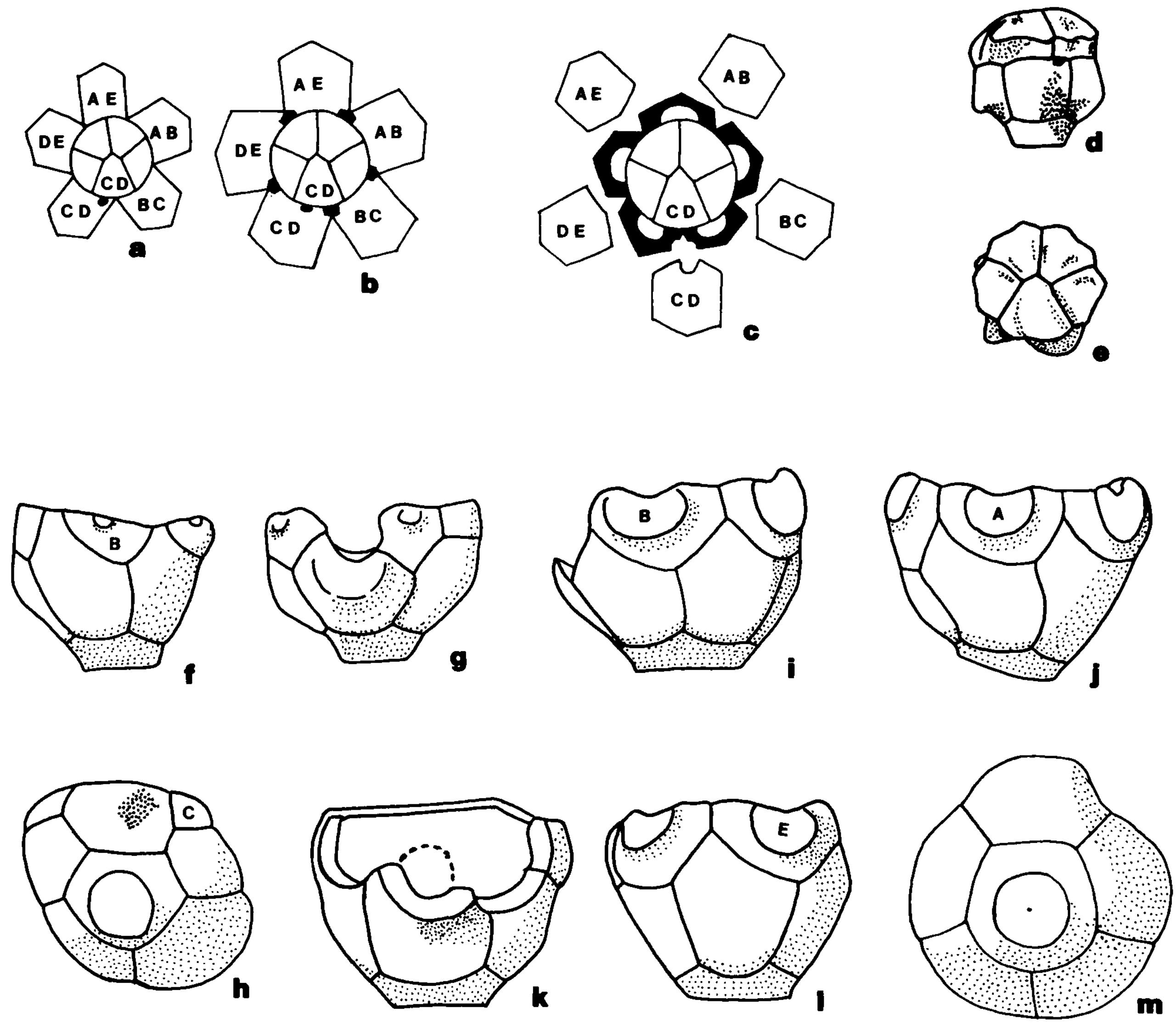

Figure 1. *Cranocrinus eximius* n. sp. from the Morrowan Stage of Oklahoma, a, b, c. Exploded diagrams of three stages of growth showing pseudomonocyclic stage, juvenile with small radials intercalated (dicyclic) and mature stage showing position of orals (if preserved). Infrabasals are not depicted and radials are black (except for arm articulating facets). Letter designations are for rays A (anterior), B, C, D and E in clockwise positions, and interrays (e.g., CD = posterior) d, e. Camera lucida drawings of juvenile (pseudomonocyclic) with CD basal to the fore and summit view with CD oral in lower position, CD basal to its left, SUI 33355a, X18. f, g, h. Camera lucida drawing of young adult with orals missing, B radial at center summit and lacking contact with A or C radials, CD interray view showing periproct, basal view with C radial at upper right, SUI 33355b, X18. i, j, k, l, m. Right lateral, anterior, posterior, left lateral and basal views of holotype, SUI 33356, X18.

Suborder CYATHOCRININA Bather, 1899
Superfamily CODIACRINACEA Bather, 1890
Family CODIACRINIDAE Bather, 1890
Subfamily CRANOCRININAE Arendt, 1970
Genus CRANOCRINUS Wanner, 1929
Type species. Cranocrinus timoricus Wanner, 1929

Description.

Theca composed of three circlets of plates as juveniles, four circlets as adults; infrabasals fused into single plate visible in side view (an occasional interinfrabasal suture may be visible); basals five, somewhat asymmetrical, CD basal elongate; radials absent in juveniles but are five and attain large size in maturity, C and D radials separated by periproct (anal opening) in adults, all others in lateral contact; radial articular facets projecting in adults, horse-shoe shaped, narrow, steeply declinate, unequal in size; periproct in side of cup, in maturity bounded by CD basal, C and D radials and CD oral; orals five, in radial position as juveniles but rotating to interradial position during intercalaction and growth of radials, forming vault over cup, hydropore may be present on CD oral, each oral centrally concave; round columnar cicatrix.

Included species.

Cranocrinus timoricus Wanner (1929), type species, *C. turbinatus* Wanner (1929) and *C. turbinatus minor* Wanner (1929), Upper Permian (Basleoan), Island of Timor, Indonesia; *C. praestans* Arendt (1970), Lower Permian (Artinskian), Kolva River, Siberia, USSR; *C.*

eximius n. sp., Lower Pennsylvanian (Morrowan), Northeastern Oklahoma, USA.

Discussion.

The suite of specimens on which Wanner (1929) based *Cranocrinus timoricus*, type species of the genus, included youthful stages; however, Wanner interpreted them as abnormal specimens. Such specimens (e.g., Wanner, 1929, pl. 1, figs. 10-13) have the aperture located on the right shoulder of CD basal (it is centered in maturity) and radial plates have not all attained sufficient stature to connect laterally.

The broad ridges elevating interoral sutures in *C. timoricus* are a feature shared with *C. praestans* Arendt (1970) and to a lesser degree with *C. turbinatus* Wanner (1929) and *C. turbinatus minor* Wanner (1929). Mature *C. praestans* and *C. eximius* n. sp. both form an outward extension of CD basal somewhat like the pouring lip of a pitcher. *Thetidicrinus* Wanner (1916) has a somewhat similar extension. *Lecythiocrinus* White (1880) has an extension below the periproct but it is a more subdued structure.

Many hypocrinoids, including *Cranocrinus*, possess an aperture in the side of the cup. The opening is usually called an anal opening or anus; however Arendt (1970) has used the term periproct. Use of this term is intended in a broad, general sense (Arendt, personal communication) but is taken here in a more specific manner. Considering the small size of the crinoid, the aperture is quite large, much larger than would be expected for a simple task of ejecting fecal waste. I speculate that the aperture served a dual function, that is, sea water may have been taken in as well as ejected.

In the absence of arms (youthful stages) some means of respiration (gas exchange), obtaining nutrition and expulsion of waste is required. I propose that armless stages or genera without arms fed in the same manner as do the modern cystidean stages of *Antedon*, that is, by opening the orals and extending suboral podia. One of the arguments against such an arrangement is the usual presence of serrations along the edges of the sutures between orals. An example of the inner side of a disarticulated oral plate with serrated edges is illustrated by Wanner (1929, pl. 7, fig. 12). An example of orals which have been preserved in a position slightly ajar is illustrated for *Acariaiocrinus clavulus* by Wanner (1929, p. 5, figs. 6, 7). It is true that larviform crinoids which possess orals are found almost always with the orals closed, but I am inclined to believe this is due more to preservation than function. Several specimens of *Cranocrinus eximius* n. sp. (e.g., SUI 33355 — SUI 33356) have been found that lack orals. Girty (1908, pl. 27, figs. 20, 20a) illustrated a specimen of *Coenocystis richardsoni* lacking oral plates.

Lane and Breimer (1974) have suggested epidermal feeding for larviform crinoids which lack external arms. There appears to be no reason to question the ability of the creatures to absorb some nutrients, such as amino acids, through the epidermis but whether to the extent of obtaining enough nutrition for growth and reproduction is another matter. A comparison between the closed theca of *Antedon* at the start of its cystidean stage, when the endoskeleton is composed of little more than film-like sieves, and a relatively thick plated mature crinoid such as *Tytthocrinus* Weller (1930) is at best out of context. The larval *Antedon* ruptures the vestibule (opens the orals) and extends podia for feeding in a very few days (Hyman, 1955, p. 81). She provides an adequate explanation of the internal source of food during the short interim period of complete closure in the cystidean stage, ". . . nutrition is obtained from cells that come to fill the cavity of the enteric sac and are there histolyzed and digested. . . . One suspects that they are amoeboid mesenchyme cells that have acquired food stores by phagocytizing degenerating tissues elsewhere in the larva."

Podia are usually thought to expand with ingress of water provided by the water vascular system. With suboral podia there would be no need for a mechanism (ligaments or muscles) to open the orals, only for the podia (or tentacles) to push them open. Ligaments to assist in closing the orals and assisting in contracting the podia were probably required and personal observation indicates that there are ligamental scars in some larviform crinoids.

CRANOCRINUS EXIMIUS Strimple, new species

Figures 1a m

Diagnosis.

Mid-portions of the basals of young specimens are projected almost as blunt spines which feature is lost in more mature specimens; orals are wide, have erect lateral sides and have an almost planate summit.

Description.

A young juvenile (Figure 1d, e) has a cup about 1.1 mm wide by 0.8 mm tall. The thecal height and width are equidimensional. Under slight magnification the thecal plates are porous-appearing which is taken as another indication of the juvenile status of the specimen.

A young adult which has also lost its orals is illustrated by Figure 1, f-h. The radial plates are not fully developed and they are not all in lateral contact. Articular facets are relatively small and it is doubtful that arms were sufficiently developed to provide full nutritional requirements. The cup is about 2.7 mm wide by 2.0 mm tall at this stage.

A larger, more mature specimen (Figure 1 i-m) has a cup of about 5.7 mm width and 4.5 mm height and lacks oral plates. Most cups are distorted in preservation, but inequality in size and shape of basal plates indicates a natural asymmetry. CD basal slopes at a lower angle than other basals, which causes the posterior side of the cup to protrude. Radials are two thirds as tall as wide and have wide, horse-shoe shaped articular facets which do not project appreciably but are steeply declinate, as is typical for the genus.

Several specimens of juvenile stages have been found but only after exhaustive search through washed residues. Very few of the larger specimens have been recovered and none with oral plates preserved. Partial or total disarticulation of associated cups of *Allocatillocrinus* which lack orals is not at all uncommon in processing procedures.

Discussion.

The holotype of *Cranocrinus timoricus* Wanner is probably adult but not mature, in that all of the radials are not in lateral contact. However, the lineage might have lost the ability to produce large radials by late Permian time. Similar stages in growth are shown by Arendt (1970, Text-fig. 34) for *C. praestans* and herein (Text-fig. 1a-m) for *C. eximius*. Only *C. timoricus* and *C. praestans* appear to have calyx sutures located on ridges. *C. eximius* has orals which produce a broad almost plane upper surface which is distinctive for the species.

Name.

Latin *eximius* for choice.

Occurrence.

See section on MATERIAL for data.

Types.

Holotype SUI 33356, figured paratypes SUI 33355 a, b.

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REFERENCES

ARENDT, YE, 1970. Crinoids hypocrinids (Morskie lilii gipokrinidy). Aka. Nauk. USSR, Trudy Paleontol. Inst., v. 128, 220 p.

FURNISH, W. M. and SAUNDERS, B. W., 1971. *in* Furnish et al, Faunal studies of the type Chesteran, Upper Mississippian of southwestern Illinois, Univ. Kans., Paleont. Contr., Paper 51, 47 p.

GIRTY, C. H., 1908. The Guadelupian fauna. U.S.G.S. Prof. Paper 58, 651 p.

HYMAN, L., 1955. The invertebrates: Echinodermata. McGraw Hill, 763 p.

LANE, N. G. and BREIMER, ALBERT, 1974. Arm types and feeding habits of Paleozoic crinoids. Koninkl. nederl. Akademie van Wetenschappern-Amsterdam Proc. Ser. B, v. 77, No. 1:32-39.

SUTHERLAND, P. K. and HENRY, T. W., 1977a. Carbonate platform facies and new stratigraphic nomenclature of the Morrowan Series (Lower and Middle Pennsylvanian) northeastern Oklahoma: Geol. Soc. Amer. Bull. 88:425-440.

_____ and _____, 1977b. Stratigraphy of uppermost Mississippian and Lower Pennsylvanian strata in northeastern Oklahoma: Okla. Geol. Surv. Guidebook 18:41-48.

WANNER, J., 1916. Die permischen Echinodermen von Timor (Tiel 1). Paläontologie von Timor, Lief 6, Teil 11, 320 p.

_____, 1929. Neue Beiträge zur Kenntnis der permischen Echinodermen von Timor: I, Allagecrinus; II, Hypocrinus: Dienst Mijnb. Ned-Indië, Wetensch Med. 11, 116 p.

WELLER, J. M., 1930. A group of larviform crinoids from lower Pennsylvanian strata of the eastern interior basin. Ill. State Geol. Surv., Rept. Invest. 21, 33 p.

WHITE, C. A., 1879 (1880). Descriptions of new species of Carboniferous invertebrate fossils. U.S. Nat. Mus. Proc. 21:252-260.